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HELIOPHYSICS SUBCOMMITTEE

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MEETING MINUTES

Jill Dahlburg, Chair

Ramona Kessel, Executive Secretary

Table of Contents

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Tuesday, September 29, 2015

Welcome, Overview of Agenda

Dr. Jill Dahlburg, Chair of the Heliophysics Subcommittee (HPS) of the NASA Advisory Committee (NAC), opened the meeting by asking those present to introduce themselves. The primary work for this meeting was to produce the Government Performance and Results Act (GPRA) Modernization Act (GPRAMA) assessment of NASA's Heliophysics Division (HPD) activities over the last year.

Heliophysics Division Overview

Mr. Steven Clarke, HPD Director, presented a Division overview. He noted that Dr. Sandra Smalley has moved on to another post within the Agency, and Ms. Margaret (Peg) Luce, formerly Deputy Division Director of the Earth Sciences Division (ESD), has moved to HPD to become Deputy Division Director of the HPD. At this meeting, Mr. Clarke planned to review HPD science highlights, the budget, the National Space Weather Strategy (NSWS), and international collaboration.

Science Highlights

In August, prior to its official commissioning, HPD's Magnetospheric Multiscale (MMS) mission recorded its first passage through the magnetosphere and captured reconnection evidenced by a flux transfer event. The data were very exciting. The Scientist in the Loop (SITL) picks interesting MMS events manually for subsequent download; when the events were compared against onboard (automatic) selections, the team found good correlations.

The Solar and Heliospheric Observatory (SOHO) discovered its 3000th comet, solidifying its reputation as one of the great comet hunters. This type of discovery is done primarily through citizen scientists. The Balloon Array for Radiation-belt Relativistic Electron Losses (BARREL) team had a very successful campaign in Sweden, with seven balloon launches. The Solar Dynamics Observatory (SDO) observed an Earth eclipse and lunar transit on the same day. The Van Allen probes celebrated their third launch anniversary. Finally, Voyager continues to make news.

Budget

In the absence of a budget for Fiscal Year 2016 (FY16), a draft Continuing Resolution (CR) is being negotiated in Congress. It appears that there will not be a government shutdown, and the CR should last through mid-December. The latest information indicated that the draft CR will fund HPD at slightly above the President's Budget Request (PBR) for FY16.

HPD relies on the 2013 Decadal Survey (DS) to guide its science priorities and resulting budget strategy. DS goals include:

- Ensuring ongoing funding for operating missions, missions in development, the principal investigator (PI) research award program, and extended operations for SDO, Van Allen, and the Interface Region Imaging Spectrograph (IRIS);
- Maintaining and growing the wedge for future missions;

- Achieving a balanced portfolio across the four program lines;
- Maintaining a viable sounding rocket/range program for the Agency; and,
- Infusing technology and innovation for the benefit of future HPD missions.

Mr. Clarke showed how the current budget aligns with the 2013 DS. Extended operations are funded as a priority, and HPD is implementing the DRIVE initiative, with the goal of full funding by FY18. The Division will release the next Explorer Announcement of Opportunity (AO) in FY16 and hopes to increase the AO cadence from every 3.5 years to every 2 to 3 years. HPD is assessing the trade space for Solar Terrestrial Probe 5 (STP-5). The next STP AO is planned for FY 17. HPD would like to have a Mission of Opportunity (MOO) with each AO. The next Living with a Star (LWS) AO will come out no earlier than 2018.

National Space Weather Strategy (NSWS)

The Office of Science and Technology Policy (OSTP) has been leading an effort to develop the NSWS. The Strategy will articulate goals to improve forecasting, impact evaluation, and enhance national preparedness for a severe space weather event. The space weather action plan will establish cross-agency actions, timelines, and milestones for the NSWS implementation.

Dr. Jeffrey Newmark has been involved in providing input to the NSWS initiative. HPD has seen the final drafts, which include many but not all of NASA's comments. Overall, Mr. Clarke is fairly satisfied. HPD and others have expressed concern about the budget supporting this. The Office of Management and Budget (OMB) and OSTP have heard these comments, which Mr. Clarke expects to be addressed.

The European Space Agency (ESA) is also interested in space weather. It is now a matter of seeing the final language and leveraging existing activities where possible. NASA works with the National Oceanic and Atmospheric Administration (NOAA) on modeling, for example. NOAA has a space weather line, and there are plenty of opportunities there. Dr. Neil Murphy asked if any international space agencies other than NASA have the capability to lead on space weather. Mr. Clarke replied that the Europeans are very interested, and the action plan addresses international collaboration.

International Collaboration

Leadership from NASA's Science Mission Directorate (SMD) and ESA met recently. Among the topics discussed were heliophysics projects such as the Solar Orbiter Collaboration (SOC). The Turbulent Heating Observer (THOR) mission is one of three down-selected proposals for the ESA M4 call. The Solar Wind Magnetosphere Ionosphere Link Explorer (SMILE) mission between ESA and China is being re-evaluated to see if both parties want to continue. The United States has some interest in participating, and would be welcome. In order to do so, NASA would deliver hardware to ESA, which would do the integration and launch. ESA is concerned about risk mitigation.

NASA met with the Indian Space Research Organization (ISRO) over the summer. Proposed areas of collaboration include modeling solar activity, joint observations and data analysis, and ground-based operations. NASA is now assessing whether to establish a joint heliophysics

working group. It would parallel a similar group in the Planetary Science Division (PSD). Mr. Clarke expects this to happen.

Mr. Clarke described some of the international missions, such as THOR, on which NASA had a briefing. It might be possible that the upcoming AO could dovetail with it, or include additional options for the U.S. science community to participate in Phase A. Dr. Ramona Kessel, HPS Executive Secretary, added that ESA will not recompete the mission, and would like European back-ups for the United States' instrument contributions.

Mr. Clarke said that although the Chinese Academy of Science (CAS) is heavily involved in the SMILE mission, that is in a partnership with ESA. U. S. involvement would be through ESA, not CAS. Dr. Mihir Desai said that in the past, he has been contacted by Indian groups wanting to do things on their own. Mr. Clarke explained that NASA sent ISRO a detailed list of options and that the two agencies are open to working together.

Flight Program Status

Ms. Luce discussed the status of the HPD flight program status, which has four lines: the Solar Terrestrial Probes (STP), which includes MMS; Living with a Star (LWS), including the Space Environment Testbeds (SETs), Solar Probe Plus (SPP), and SOC; Explorers; and the Research Program. HPD has 19 missions in orbit, and 33 spacecraft associated with those mission. The Division relies on many on-orbit assets that live past their initially-designated mission lives.

MMS launched in March and is still in its nominal orbit. The early science results are excellent. MMS entered Phase E on September 1. The spacing of the constellation is gradually decreasing. In each configuration, the scientists will determine the optimum spacing. There has been an anomaly with a data downlink on one spacecraft; it seems to be a mere glitch, but nothing formal has been determined. The science team should complete testing of the distances for the day side in December, then begin work on the night side.

The LWS SET-1 mission is focused on improving engineering and on-orbit variability. The Ionospheric Connection Explorer (ICON) is under development and is on schedule to launch in October 2017 on a Pegasus rocket. All instrument hardware is in development and testing. The Global-Scale Observations of the Limb and Disk (GOLD) is an Explorer Mission of Opportunity (MOO) that will be hosted on a commercial spacecraft. The pre-shipment review will be in October 2016 and the mission will be ready to launch in April 2018. SPP is scheduled to be launched in July 2018. It will go closer to the sun than any previous mission, so a lot of the work has to do with thermal protection systems. A few issues have come up regarding an antenna and the communications links. The mission operations review will take place in November.

For SOC with ESA, which Mr. Clarke discussed, NASA is providing two instruments. These are the heavy ion sensor and the solar orbiter heliospheric imager, which are on track for delivery in October 2016. There could be schedule slippage on ESA's end, however. Mr. Clarke explained that that would affect getting into the queue for launch, which is to be on an Atlas 5 launch vehicle. ESA can still address the margin and is looking at how this can be managed. The spacecraft did not pass ESA's Critical Design Review (CDR). ESA is making good progress in addressing this, but now the programmatics lag.

Ms. Luce said that there were three recent sounding rocket launches; the current cadence is about 25 annually. There have been some concerns about the Black Brant sounding rocket, though it was scheduled to launch soon; the team has a potential back-up program. In HPD's operating mission suite, the most notable item is that the Solar TErrestrial RElations Observatory (STEREO) B spacecraft has been out of communications for some time. NASA plans to attempt contact again in the spring. STEREO A is working quite well, however. NASA will no longer partner with ESA on Cluster after FY15, as the Agency contribution was instrumentation. The C/NOFS mission is likely to re-enter in November.

Dr. Murphy noted that PSD was about to release an AO for ice giants, an area of overlap with heliophysics. He suggested that HPS members publicize this to the community. Mr. Clarke said that he and Dr. James Green, PSD Director, had discussed doing joint calls in the future. Dr. Spiro Antiochos said that the Japanese Space Agency (JAXA) would be interested in Solar C and other projects. Involving JAXA at the outset could be an opportunity for both agencies.

Heliophysics Science Performance Assessment Review – Overview

Dr. Newmark explained the Government Performance and Results Act Modernization Act (GPRAMA) evaluation. This is important feedback for HPD and NASA regarding whether HPD is making progress. The Agency is required by law to have an outside review, and HPS fills that function for HPD.

The process at NASA has evolved over time, employing the framework from the 2014 Strategic Plan. The resulting Strategic Objectives Annual Reviews (SOARs) have deemed HPD as "noteworthy" in addressing its strategic objectives, performance goals, and indicators. The indicators are annual, based on the GPRAMA evaluations. OMB will use the SOAR information to understand HPD plans, to see how the Division justifies its budget, and to determine where the Division can take action.

Dr. Newmark presented the GPRAMA objectives. The overarching objective is Objective 1.4, to understand the Sun and its interactions with Earth and the solar system, including space weather. Associated with that objective are multi-year performance goals:

- 1.4.1 is to demonstrate progress in exploring the physical processes in the space environment from the Sun to Earth, and throughout the solar system.
- 1.4.2 asks HPD to demonstrate progress in advancing understanding of the connections that link the Sun, Earth, and planetary space environments, and the outer reaches of the solar system.
- 1.4.3 seeks to demonstrate progress in developing the knowledge and capabilities to detect and predict extreme conditions in space, to protect life and society, and to safeguard human and robotic explorers beyond Earth.

HPS was being asked to evaluate whether HPD made progress in each of these areas over the 12 months. HPD staff had provided materials to support the color-coded ratings, and the document needed a couple of published citations from each area as short, explanatory text. The examples that HPD sent to HPS served as a starting point, and the Subcommittee was not obligated to use them. The resulting document would be read by financial personnel, OMB, and Congressional

staff, so it was important to convey the exciting science that HPD is doing on a level that educated non-scientists can understand.

The SMD criteria for GPRAMA voting are as follows:

- Green – Expectations for the research program fully met in context of resources invested.
- Yellow – Some notable or significant shortfalls, but some worthy scientific advancements achieved.
- Red – Major disappointments or shortfalls in scientific outcomes, uncompensated by other unusually positive results.

A rating of Green does not mean that the problem has been solved, it means that progress has been made. The evaluations should also take into account the resources that HPD actually received and were available to use. A Yellow rating means that there has been a shortfall in terms of the resources available. Ms. Jennifer Kearns of SMD explained that the Astrophysics Division (APD) had a Yellow rating a number of years ago for a mission that was experiencing continued delays. By that time, the science community had expected to see significant data from the mission, but there were none.

Dr. Newmark explained that the citations for the examples were important internally but would not be included in the final report. The important thing was to show progress. It is fine to include pictures, which may go into the accompanying document. HPS could provide multiple examples for each criterion, but HPD would select only two or three. Ms. Kearns added that the SMD writing staff will assess what will capture the public's attention. If there is an item that is highly significant but is hard to translate for the layperson, SMD can work that out.

<u>Heliophysics Science Performance Assessment, Input for the FY2015 NASA PAR – Review and Assignments</u>

Dr. Dahlburg reviewed the charge, then suggested that the HPS break into subgroups, one for each of the three objectives HPS was to evaluate. The subgroups included the following members:

- Objective 1.4.1: Dr. Bart De Pontieu, chair; Dr. Murphy; Dr. Antiochos; Dr. Dahlburg.
- Objective 1.4.2: Dr. Vassilis Angelopoulos, chair; Dr. James Russell; Dr. Desai; Dr. Ralph McNutt.
- Objective 1.4.3: Dr. Michael Liemohn, chair; Dr. Heather Elliott; Dr. Roger Smith, Dr. W. Kent Tobiska.

The groups reconvened after a period of work.

Dr. De Pontieu explained that his group had narrowed down the examples to four stories. In addition to the material provided by HPD, the group wanted to note the simulations that show how weather causes gravity waves in the ionosphere. Other examples included the Interface Region Imaging Spectrograph (IRIS) resident absorption, which was related to the HSO; the modeling and observations of the Kelvin-Helmholtz waves at the edge of Earth's space environment; and the plasmasphere (magnetosphere) work. There was some debate from the full Subcommittee about whether or not to separate the Kelvin-Helmholtz observations from the

plasmasphere discoveries. After further discussion, it was agreed to drop the fourth (plasmaphere) item and expand the Kelvin-Helmholtz wave discussion.

Dr. Angelopoulos presented the work of the group addressing Objective 1.4.2, which dealt with connections. The group emphasized three themes. The first theme was the effects of the solar wind on the upper atmosphere, with three discoveries showing HPD progress in finding how solar wind competes with manmade effects. The second theme was the outer heliosphere, again with three examples. Finally, the group felt that it was important to include planetary interactions with the Sun, and therefore found that results from the Mars Atmosphere and Volatile Evolution Mission (MAVEN), the MErcury Surface, Space ENvironment, GEochemistry, and Ranging (MESSENGER) mission, and others to be worth mentioning. Dr. McNutt pointed out that these missions are appropriate in terms of interaction criteria, but PSD paid for them. Ms. Kearns said that HPS was free to call in work paid for elsewhere in NASA. Dr. Newmark added that linkages can be compelling. For example, HPD used MESSENGER detection of neutrons with observations from STEREO a few years ago. Tying in the two groups would be even more powerful, as it would show joint observations.

Dr. Liemohn said that for Objective 1.4.3, the group selected three examples. The first was the equatorial plasma bubble prediction, which has a big influence on GPS and radio signals. The second example was from the Van Allen probes, regarding the plasmaspheric hiss. The third had to do with measurements from the SDO of the strength of Coronal Mass Ejections (CME) eruptions.

Science Presentation: Space Weather Products at the Community Coordinated Modeling Center (CCMC)

Dr. Masha Kuznetsova and a team from the CCMC provided a lunch presentation on the Center's capabilities. Dr. Kuznetsova noted that if an investigator wants a capability that is not yet available, the team will develop it provided that there is a clear description. The product then becomes available to all. CCMC has scientists in each domain to help out. Mr. Marlo Maddox provided additional information about data storage and modeling, including a software suite called Kameleon. These products can be run on a laptop, and some are available to be downloaded onto smartphones.

Subcommittee Work Session

After further work on the materials accompanying the three GPRAMA objectives, HPS reviewed the drafts.

Dr. De Pontieu said that the section on Objective 1.4.1 would open with a statement that "[e]xploring the physical processes that structure and drive our space environment is essential for the utilization and the human exploration of space and, consequently, is one of the great challenges for NASA's science program. … HPD has made major progress recently on understanding the physical mechanisms underlying the heating of the solar corona, energization of the magnetosphere, and the dynamics of the Earth's upper atmosphere." The three examples would address IRIS, SDO, and solar heating; gravity waves; and the Kelvin-Helmholtz reconnection.

For 1.4.2, the team said that "using data acquired from the HSO and modeling, NASA has achieved significant progress in this area." The three supporting topics were the Interstellar Boundary Explorer (IBEX) observations of energetic neutral atom observations revealing plasma flows; solar wind affecting Earth's upper atmosphere; and the MESSENGER and MAVEN observations.

The section on threats, Objective 1.4.3, was to open by noting that "NASA mission data and NASA-funded numerical models across all heliophysics disciplines were used to advance understanding of space weather that could adversely affect life on Earth." The three examples remain the equatorial plasma bubble prediction, the plasmaspheric hiss, and measurements from the SDO of CME eruptions.

Research Opportunities in Space and Earth Sciences (ROSES) Exit Survey for Proposers and Panelists

Dr. Kessel explained that she was presenting a draft of a proposed ROSES exit survey and that HPD was still looking at which questions to ask. PSD does a survey using Survey Monkey and has found that scaling and boxes work best. Survey Monkey is free within certain limitations. In PSD, each individual is given a randomized code to enter so that no one intercepting data could connect responses to individuals. There have been no issues with security and no proprietary information is involved. The response rate thus far has been high, and the information gathered is useful.

The HPD survey will offer a box in which respondents can make suggestions for improvement. Dr. Murphy cautioned against setting up a scenario that compels the Division to act, which could happen in the case of certain negative responses. Dr. Liemohn advised in favor of a box that seeks opinions about what went well and what could be improved. Dr. Kessel noted that Dr. Liemohn sent her the American Geophysical Union (AGU) peer review feedback, which is similar to the way she hopes to construct the HPD survey. It includes a single comment box for all of the questions. She was inclined to follow the AGU format.

When asked about assignment of reviewers, Dr. Kessel said that she sends them abstracts of the proposals and asks for their comfort level, then assigns panels accordingly so that proposals go to leads who are the most comfortable with the subject. The process also tells her how much expertise is lacking and helps her identify areas in which she needs to search for reviewers. Dr. Dahlburg suggested that HPS recommend that this process be used throughout HPD reviews.

Dr. Kessel said that the survey code should be distributed at the panels, and a decision should be made soon in order to get feedback from 2015. HPD could either conduct a pilot survey or send another set of draft questions to HPS in order to put the survey in place for the current panels. It was noted that PSD was able to do a survey without approval from NASA's General Counsel's Office (GC), but it might be a good idea for HPD to notify the GC that this was about to occur.

Cost-to-Benefit Ratio in Flight Project Reviews, NAC-Science Committee (SC) View

Dr. Murphy presented the HPS concerns about excessive review to the last NAC SC meeting, which took place over the summer at the Jet Propulsion Lab (JPL). HPS was concerned about the level and number of reviews for many flight projects, the increasing formality of which has been

creating a tremendous amount of work. The SC agreed that HPS should try to put together a picture of this, which should be concrete and actionable. He heard off-line that this has been examined before Agency-wide, and it was found that center management drives these reviews, as the centers are trying to avoid failure. However, this finding does not seem to be helping anything.

Dr. Dahlburg suggested that the Subcommittee members bring to the next meeting some concrete suggestions about gathering data. Dr. McNutt said that he has the data on MESSENGER on his laptop, and if MESSENGER has the data, other missions have it as well. It then becomes a matter of finding and gaining access to those data. Dr. Newmark said that HPD probably has a reasonable database of the reviews, though from the program office perspective. Access might not be a simple matter. Dr. Murphy gave the example of how peer reviews used to be tabletop reviews, but are now much more complex, with action items and pre-review reviews. The program office might not know about all of these reviews.

Dr. Antiochos recommended comparing two Explorers, possibly the Transition Region and Coronal Explorer (TRACE) and IRIS. Both ran smoothly and were 10 years apart, so they would make good comparisons. Ms. Luce pointed out that overruns were more of a problem in the TRACE time period. Now NASA is much better at delivering on its promises, which removes some Congressional pressure. There is some performance benefit in the current era. She would have HPS look at the quality of the reviews as well. It could be that the pre-reviews have benefit. Dr. Liemohn noted that that is what HPS wants to know: are these reviews useful?

Dr. Murphy also discussed payload adapter fittings (PAFs) at the SC meeting. Because the issue is rather complex and often hard to explain, it did not get the best presentation before the full NAC. Therefore, it was concluded that the PAF issue needs to be approached differently. Another thing that came up was the NASA Administrator's concern about the radiation risk for a potential human transit to Mars. Space weather is a factor in this, so it would be useful for HPS to learn what Mr. Charles Bolden, the Administrator, wants and needs. He is currently convinced that this is not a solved problem. It presents an opening for NASA science. Mr. Clarke noted that the Human Exploration and Operations Mission Directorate (HEOMD) and SMD have discussed the risks and space weather.

PAF, NAC-SC Discussion and Next Steps

Dr. Dahlburg said that in a phone call with Dr. Bradley Peterson, Chair of the SC, she and he agreed that the PAF topic is very worth exploring. However, HPS must develop a comprehensive and documented discussion that he can take to the NAC. They agreed that HPS should develop a 5-page report that summarizes the issue, provides at least two distinct scenarios of how NASA could use PAFs, and includes explicit discussion of how to achieve the funding. Finally, the report should include information about who uses PAFs and their experience in regard to safety and capabilities. Dr. Peterson would be happy to pass this report along to the NAC. This should also be something that is agreeable to Mr. Clarke.

Dr. Dahlburg suggested that the HPS could proceed by setting up a subgroup to write the report that could go back to the SC, Dr. Peterson, and the NAC. Dr. McNutt cautioned that there are people who are completely unfamiliar with PAFs. Mr. Clarke suggested that it go to SMD, which

he would be willing to manage. The other SMD division directors should be aware of this option. PAFs would have to go through NASA Launch Services (LS) for the proper safety evaluations. One issue is which party pays for the launch. He would like to gauge interest from the other divisions, then discuss how to address costs. He did not see a problem with charging HPS to write a paper on PAFs.

Dr. Newmark said that he was not completely clear about the issue because this is allowed in AOs. Dr. Murphy said that the APD Small Explorer (SMEX) AO brought in a proposal that included a PAF, and the Technical, Management, Cost, and Other (TMCO) assessment gave it a major weakness. Dr. Murphy maintained that no one believes that they can write a successful proposal with a PAF.

Dr. Russell said that if LS has already assessed risk, a PAF might be possible, but otherwise proposals will always get called on the risk. Dr. Newmark pointed out that PIs will be assigned risk for anything new, and Mr. Clarke added that they will have a safety review regardless. He was still unclear as to the issue they were trying to solve, beyond having more awareness. The 5-page report would be a starting point that HPD could edit. Ms. Luce observed that HPS seemed to also want to advocate that NASA invest in making this approach viable. Dr. Dahlburg asked Mr. Clarke to provide further feedback.

Adjourn

The meeting adjourned for the day at 5:04 p.m.

Wednesday, September 30, 2015

Recap of Meeting Progress

Dr. Dahlburg reviewed the previous day's activities. Mr. Clarke said that in regard to the PAFs, he directed HPD staff to do two things to address the topic and provide information to HPS. First, he asked them to define the current capability for fueled PAFs, including gathering information within NASA. He also asked them to assess the language in recent AOs and in the upcoming Explorer AO, then provide a short report to HPS. They will determine what currently exists and what is available. Dr. Dahlburg thanked him, and on behalf of the HPS gladly accepted the Mr. Clarke's offer.

Technology Readiness Level (TRL) Discussion

Dr. Elsayed Talaat, the intended speaker on this topic, was unavoidably delayed; Dr. Newmark began the presentation in his stead. Dr. Newmark said that he had been hearing that there is a disconnect between the internal and external views of TRLs, and HPD hoped to break down any perceived barriers. In 2014, the NAC received a recommendation to infuse technology into small and medium-class science missions. NASA responded that there does need to be a pathway to advance technologies, but that there is already a means to do so. Dr. Newmark noted that the current requirement for Explorers, for example, is TRL 6 by preliminary design review (PDR). That requirement evolved over time due to issues that occurred when low TRL technologies went to confirmation and created uncertainty.

The question concerns the pathway. For example, if a PI wants to fly a TRL 3 detector on an Explorer, how is that done? NASA has a small technology development program, a low-cost access-to-space program, and International Space Station (ISS) programs that fly low TRL products. About half of the HPD missions have followed these pathways. Dr. Newmark provided a couple of examples, emphasizing the balloon and sounding rocket programs. Not all technologies or measurements lend themselves to the various airborne programs, but NASA tries to be creative.

Dr. Murphy said that a proposal with a technology that is not yet at TRL 6 must have a back-up in case the team cannot mature the technology. This means proposers really do need a TRL 6. In addition, there has been a slight creep in the requirement to move from components at TRL 6 to systems at TRL 6, which is very difficult for any PI who is at a university. Dr. De Pontieu added that the requirements impose criteria that only large centers or corporations can fulfill.

After further examples from HPS members, Dr. Newmark said that HPD could take an action to double check the requirement and determine if there has been a change. Dr. Michael Seablom, the SMD Chief Technologist, said that the technology programs primarily help technologies reach TRL 5. The more important question is whether the technology programs have sufficient funding. Dr. Daniel Moses pointed out that the SMEXes and Mid-EXes are programs meant for a relatively fast timeline, so if the technology is not at TRL 6 by confirmation, it is doubtful that the mission will achieve that on the timeline. That is the inherent drawback of the small programs. Dr. Newmark said that if there is a question at confirmation, the mission team is not going to meet the management agreement. That is the norm. Everyone loses when that occurs. HPD does have to be careful. He reiterated that HPD would take an action to see if this has gone too far and to see if HPD can enable the science community.

Dr. De Pontieu said that on proposals for other NASA science divisions, his organization is being told that they need a system at TRL 6. Dr. Talaat replied that the problem has been when components come in at TLR 6 but have not been tested together and there is no plan. If there is a plan, TMCO will assess it. He promised to look at the language along with Dr. Newmark. Dr. McNutt added that taking a technology from TRL 5 to TRL 6 is quite expensive. In the absence of the requisite funding, proposers become optimistic about the TRL; that is a subtext, especially if something is on the edge of TRL 6. Dr. Dahlburg asked Drs. Talaat and Newmark to provide an example showing the typical best path.

<u>Geospace/Management Operations Working Group (G/MOWG) Report</u>

Dr. Douglas Rowland gave an update on G/MOWG. The Group last met in May 2015 and was about to meet again. Some of the previous findings were overcome by events. More recent findings address technology development, strategic planning for LWS and STP missions, increased Explorer flexibility, Guest Investigator (GI) funding for MMS, and a framework for the sounding rocket program.

In the area of technology development, the findings proposed the following:

- Funding Category 3 Explorers;

- Asking science definition teams (SDTs) and other advisory groups to identify technology development roadmaps for high-priority science targets, with the STP and LWS programs investing to develop these before Phase A;
- Increasing the emphasis on developing long-term technology needs in anticipation of the next DS; and,
- Finding rides for access to space.

Dr. Dahlburg, who chairs the Department of the Navy (DON) Space Experiments Review Board (SERB), noted that the DON and Department of Defense (DOD) SERB processes are very successful, and suggested that analogous processes for NASA might help move NASA technologies forward.

In regard to strategic planning for LWS and STP, G/MOWG advised that HPD consider starting SDTs now for missions in the future, establish smaller SDTs for PI-led missions, and complete the high-priority DS recommendations before starting these missions. An earlier recommendation for increased Explorer flexibility has been overcome by events, specifically the upcoming AO and the Notice of Intent. Other things to consider are ISS investments up to the full SMEX cost cap; cubesats at the full $65 million MOO cost cap; Class D cubesats with a NASA-provided ride at $50-65 million; a SMEX capability of providing its own ride to orbit; and permitting 12-unit cubesats. Communication among cubesats is currently a proposer issue that could be addressed further.

G/MOWG would like HPD to consider an open GI opportunity with no MMS, along with a dedicated call for MMS GI proposals in the 2016 ROSES call. A dedicated MMS call in mid-2016 will allow the community time to examine the data. G/MOWG would also like to see a broadened scope for the MMS GI, and dedicated GI funding for future missions. Finally, the sounding rocket program should consider implementing a proposal framework and schedule that allows mobile campaigns as a regular part of the Heliophysics Technology and Instrument Development for Science (H-TIDeS)/ low-cost access to space (LCAS) program.

Big Data Task Force

Ms. Elaine Denning of NASA explained that the Agency has set in place a Big Data Task Force (BDTF) as part of the plan to evolve NASA's big data initiative. This is part of a larger, government-wide effort. The NASA BDTF will be made up of 10 people from across the science disciplines, an IT person, an aerospace member, and two industry representatives. The first meeting will be in the fall of 2015 and address issues of interoperability and accessibility. Each SMD subcommittee sees data needs differently, so SMD is reaching out to each to discuss task force needs, goals, objectives, tasks, and deliverables. This will be a FACA committee, and it will have an advisory role regarding infrastructure.

Dr. Dahlburg commented that heliophysics has two main drivers in using big data: SDO, and heterogeneous data that investigators want to match at a particular time cutting across many data sets. Dr. Liemohn noted that he can easily generate a terabyte of data from SDO alone. Visualization is another factor that should be included. Ms. Denning added that within SMD, ESD and HPD are more the focus of big data than are APD and PSD. Dr. Dahlburg said that it would be helpful for NASA to enable the divisions to capitalize on each other's work; for

example, HPD data might benefit from the Ames Research Center (ARC) products that ARC develops for the analysis of Earth data.

Dr. McNutt said that interfacing with big data sets can be an issue. In the various divisions, there are different sociologies and non-obvious cultural differences that affect big data usage. In that regard, familiarity becomes an issue. The BDTF might want to think about interoperability and usability. Dr. Angelopoulous observed that many of the datasets relevant to NASA come from the NSF ground-based operations, and wondered about NASA/NSF cross-over. Dr. Jeffrey Hayes of NASA agreed that the two agencies should be in communication on this. However, Ms. Denning said that at this time, the NASA BDTF is dealing with NASA issues only.

Dr. Elliott said that one unique need within her group is that they use data taken across different timeframes, some of which are long. This requires flexibility in the datasets. Dr. Angelopoulos noted that often the issue is not so much size as the need for heterogeneity. He suggested that that be considered as part of usability. Dr. Hayes agreed, stating that there is a need for standards among the divisions and with modelers, who often have their own standards. Dr. Elliott said that she has also worked with data from PSD and APD. PSD tries to make everything fit a format, which goes too far in that data are left out if they do not fit.

Ms. Denning reiterated that there will be two industry seats on the task force, but the science perspective is necessary. Ms. Luce explained that, due to involvement in the National Climate Assessment, ESD was asked to put data online and invest further. It is important to take advantage of the evolving IT systems to optimize investments and know what each other is doing. Companies such as Google and Microsoft want to partner with NASA as well, which can facilitate leveraging of their power and capabilities.

Dr. Angelopoulos suggested seeing how similar tools are used in the various disciplines, which Dr. Dahlburg concurred as worthy of follow-up. Ms. Denning promised to report back on the Task Force activities in the future.

Astronomy and Astrophysics Advisory Committee (AAAC) Proposal Pressures Study Group Interim Report Summary

During the lunch break, Dr. J. Todd Hoeksema presented the interim report of the AAAC study on the falling success rates of proposals across the astronomical sciences. The basic problem is that the rising number of proposals, combined with flat budgets, has led to declining success rates. Dr. Hoeksema provided background data to illustrate the decline. As success rates have dropped from upwards of 30 percent to the mid-teens, many organizations have responded by writing more proposals.

Past the funding level and number of proposals, there are demographic questions. AAAC sought to determine if there are changes in submission rates, the number of PIs, ages of PIs, institutions, and the quality of proposals. It also looked at whether rejected proposals are being recycled.

The study found few changes in the PI submission rate, or submissions per individual PI. Most PIs submit a single proposal. There have been no changes in PI ages or gender, aside from a slight increase in the ratio of women among younger PIs. Nor has institutional affiliation

changed much. Proposal grades have not changed notably, but the real impact has been on the Very Good (VG) proposals, which are being funded at a much lower rate than previously. Excellent (E) and E/VG proposals have been funded at the same rate. The study did find that some unsuccessful proposals are being resubmitted, from 40 to 60 percent over the last 10 years.

Among the impacts, the study found that staff managing review panels have more work, and reviewers are busier. There are more issues in reviewer recruitment and conflict of interest (COI). There are also cost issues. For example, the cost of all APD reviews comes to about $3 million, or $4,000 per proposal and $20,000 per successful proposal.

A healthy level of competition identifies the best science and boosts productivity. Unhealthy success rates discourage innovation and cause inefficiencies. If someone is new to the field or not funded, there is an unconscious bias - which has been documented - so these proposers have a lower chance of success. Success rates of 15 percent or less are not sustainable: people leave the field or do not innovate. The solutions to this situation are not clear.

Dr. Antiochos proposed that shorter or staged proposals would solve some of these issues and encourage creativity. Dr. Hoeksema said that he was not certain that the amount of time to prepare a proposal relates to the length. Reviewers often look for flaws. In answer to a question about demographics, Dr. Hoeksema said that the number of PIs has risen, while the dollars per year have stayed constant. Anecdotal information indicates that the field has grown.

Dr. McNutt asked about the number of survey respondents who have always been supported on grants, and the number typically supported on flight projects, which cadre used to be much larger. This has been a significant problem in other SMD divisions. Dr. Hoeksema said that the AAAC survey did not look at that comparison. There are anecdotes about the possible effect on state universities and others with lower budgets, but no data. There is not a great increase in younger people submitting, although they may be on teams and therefore not evident. One issue is that some of the data needed for a more expansive picture are hard to collect. If there are fewer funds available, the field will have to adjust. The question then becomes whether that should happen organically, or whether funders should target certain areas.

<u>Heliophysics Science Performance Assessment, Input for the FY2015 NASA PAR – Working</u>
Dr. Dahlburg asked the Subcommittee to think about summary statements resulting from the meeting. These were presented at the end of the meeting.

GPRAMA
Next on the agenda was the GPRAMA ratings vote. HPS first discussed Objective 1.4.2, which had to do with connections. Dr. Angelopoulous read the introductory statement, which said that NASA has achieved significant progress in this area, especially in examining the solar variability of Earth's ionosphere and upper atmosphere, revealing the interaction of the solar wind with the interstellar medium, and unveiling how solar-driven electric currents and particles connect to and influence the extended planetary environments of Mars and Mercury.

The supporting examples were the following:

1. Solar wind, long-term CO_2, and atmospheric wave activity observations point to a changing atmosphere.
2. Planetary spacecraft provide new insights into solar wind interactions with solar system bodies.
3. IBEX, Voyager, and Cassini illuminate the heliosphere's structure and its interstellar interactions.

After some edits and clarifications of the text on the three examples, HPS took the ratings vote. The vote was unanimous in favor of a Green rating.

Dr. De Pontieu read the introductory statement for Objective 1.4.1, on exploring physical processes in the space environment from the Sun to Earth. The statement noted that HPD had made major progress in understanding the physical mechanisms underlying the heating of the solar corona, energization of the magnetosphere, and the dynamics of Earth's upper atmosphere.

Following are the supporting examples:
1. Coronal heating mechanisms caught in the act.
2. Solar sources of charged particles in near-Earth space, also known as the Kelvin-Helmholtz waves discussion.
3. Simulations of planetary-scale mesospheric gravity waves.

The Subcommittee provided edits for the text of the three examples, then voted unanimously to give this objective a rating of Green.

Finally, Objective 1.4.3 spoke to the fact that NASA-funded data and models were used to understand space weather phenomena that affect and possibly threaten life.

The group chose the following as examples:
1. Coronal dimming serves as a proxy for coronal mass ejections.
2. The absence of high-energy electrons in the inner radiation zone.
3. New predictive capability for equatorial ionospheric scintillation.

HPS reviewed the text of the three examples and voted unanimously in favor of a Green rating for this objective.

Future Meetings
It was agreed that all of the 2016 HPS meetings would be arranged soon in order to facilitate planning by the Subcommittee members. Dr. Dahlburg offered to look into a schedule tie-in with the annual late June meeting of the DON SERB, which addresses some topics of interest to HPS. The AAAC report was suggested as a topic for the January/February teleconference, along with the PAF document that HPD agreed to provide to the HPS, the TRL information, and the BDTF update.

Dr. McNutt raised the issue of travel restrictions, which he had previously researched and wanted to pursue further. Dr. Dahlburg agreed, and suggested providing Dr. McNutt's latest documentation to Mr. Clarke and Ms. Luce. Others on the Subcommittee volunteered to

investigate the situation at their respective institutions and forward their findings to HPS and HPD. Another topic proposed for the teleconference was the cost-to-benefit ratio, which would have a deeper discussion at the spring meeting. HPS members also offered to find information relevant to this discussion.

Dr. William Kent Tobiska raised a concern he had that was internal to heliophysics, which was the public perception of heliophysics. Each of the other SMD divisions seemed to have a tag line or image, but it was not clear what was going on in the heliophysics discipline that could capture the public's imagination. Dr. Dahlburg said that all space-based capabilities are subject to the effects of the space environment, which can be very important and hence is a compelling perspective they can promote. Dr. McNutt agreed, noting that that space weather affects how well GPS devices work. Dr. Dahlburg suggested that HPS members take this as a point to consider further.

Debrief with Heliophysics Division Director

Dr. Dahlburg provided the following remarks:

1. HPS was grateful for the dates for the AOs and missions. The science highlights were fascinating, especially regarding MMS and the SITL, and it was very exciting to the HPS to hear how the Great Observatory concept goes back to Voyager. The inter-agency interactions are very promising.
2. HPS welcomed Ms. Luce with her background and expertise, and anticipates that her broad experience with complementary Earth Science missions will immensely benefit heliophysics research.
3. The CCMC talk was excellent, and the information about Kameleon was received with much interest.
4. The exit survey presentation was helpful, and HPS recommended that all of the HPD panels be set up with primary reviews assigned to those who are most comfortable with the topics.
5. HPS was pleased that Mr. Clarke assigned HPD to analyze the PAFs and provide a short summary for the HPS.
6. The TRL discussion was quite helpful and HPS looked forward to learning more.
7. The HPS found the G/MOWG findings, summarized below, to be both interesting and helpful:
    i) On technology development: Consider funding suitable Explorer proposals rated Category-3 (Class C/D) and announcing this well before the AOs appear.
    ii) On strategic planning for LWS and STP missions, which used to be frequent and now occurs for the most part only at a cadence driven by the Decadal Survey: Consider starting Science Definition Teams now for foreseeable 'reference' missions such as IMAP (Interstellar Mapping and Acceleration Probe), DYNAMIC (Dynamical Neutral Atmosphere-Ionosphere Coupling), MEDICI (Magnetosphere Energetics, Dynamics, and Ionospheric Coupling Investigation), and GDC (Geospace Dynamics Constellation).
    iii) On increasing Explorer flexibility: Consider releasing a non-binding 'Notice of Intent' to give the community maximum time to prepare excellent concepts.
    iv) On Guest Investigator funding for MMS: Since it is anticipated that the data from MMS will be released to the public in March 2016, consider issuing a dedicated

MMS GI call in the summer of 2016, and allow for broadened scope of investigations as compared with limiting to official MMS goals.

v) On a framework for sounding rocket mobile campaigns: Consider implementing a proposal framework and schedule that would allow mobile campaigns to become a regular part of the H-TIDeS program.

The HPS endorsed all five of the above-listed findings as valuable and important towards strengthening excellence in research directions in the workforce.

8. HPS was happy to provide input to the BDTF and to learn of this effort, and noted strong agreement with the goal of better data transparency across the SMD Divisions.
9. The AAAC interim report information was beneficial, and HPS is looking forward to review it further once the final report is released.

Regarding travel, Dr. McNutt explained that he made an inquiry and put together some material on how the system is still broken. There are multiple issues, which procurement offices seem to not understand. He would provide his documentation to Mr. Clarke in order to show concrete examples of problems in the system. HPS was pursuing additional examples.

Dr. Dahlburg introduced the GPRAMA evaluations. HPS unanimously voted to give all areas a rating of Green. Dr. Murphy presented Objective 1.4.1, explaining that the group determined that HPD is making great progress in this area. Examples were coronal heating mechanisms observed in action, solar sources of charged particles in near-Earth space, and simulation of planetary-scale mesospheric gravity waves.

Dr. Angelopoulos said that HPD made seminal contributions in connections, covered by Objective 1.4.2. The three examples were the competing effects of ionospheric heating by the solar wind and cooling by atmospheric CO_2, insights provided by planetary spacecraft into solar wind interactions with solar system bodies, and the contributions of IBEX, Voyager, and Cassini in illuminating the heliosphere's structure and its interstellar interactions.

Dr. Liemohn said that for Objective 1.4.3, NASA mission data and models advanced understanding of space weather phenomena that could be threats. Examples were the finding that coronal dimming serves as a proxy for coronal mass ejection strength, discovering that the inner radiation zone contains no high energy electrons, and the new predictive capability for equatorial ionospheric scintillation.

Mr. Clarke thanked HPS for its hard work over the two days of the meeting and credited his staff, led by Dr. Newmark, with putting together a good GPRAMA package for the Subcommittee. He looked forward to providing responses and receiving the additional HPS materials. Ms. Luce thanked them for their effort and, especially, the positive, constructive approach the Subcommittee took.

Adjourn

The meeting was adjourned at 5:05 p.m.

Appendix A
Attendees

Heliophysics Subcommittee members
Jill P. Dahlburg, Naval Research Laboratory, Chair
Vassilis Angelopoulos, UCLA
Spiro Antiochos, NASA GSFC
Bart W. De Pontieu, Lockheed Martin
Mihir Desai, Southwest Research Institute
Heather A. Elliott, Southwest Research Institute
Michael W. Liemohn, University of Michigan
Ralph L. McNutt, Jr., Johns Hopkins University
Neil Murphy, Jet Propulsion Laboratory
James Russell III, Hampton University
Roger W. Smith, University of Alaska
William Kent Tobiska, Space Environment Technologies
Ramona Kessel, NASA HQ, Executive Secretary

NASA Attendees
Nils Emil Axelsson
Max Bernstein
Justin Boblitt
Eric Christian
Steve Clarke, HPD Director
Rebecca Doroshank
Jeffrey Hayes
Michael Hesse
Willis Jenkins
Jennifer Kearns
Maria Kuznetsova
Robert Leamon
Peg Luce
Dan Moses
Jeffrey Newmark
Tomas Forsyth Rosin
Doug Rowland
Jenny Rumburg
Michael Seablom
Bill Stabnow
Elsayed Talaat

Other Attendees
Lamont DiBiasi, SwRI
Eric Hand, Science Magazine
Ben Kallen, Lewis-Burke Associates
Dan Leone, Space News
Nathan Schwadron, University of New Hampshire
Elizabeth Sheley, Zantech IT
Allison Thompson, Lewis-Burke Associates

Appendix B
Subcommittee Membership

Jill P. Dahlburg, Chair
Naval Research Laboratory

Ramona Kessel (Executive Secretary)
NASA HQ

Dr. Vassilis Angelopolous
UCLA

Dr. Spiro Antiochos
NASA GSFC

Bart W. De Pontieu
Lockheed Martin

Mihir I. Desai
Southwest Research Institute

Heather Elliott
Southwest Research Institute

Maura Hagan
National Center for Atmospheric Research

Michael W. Liemohn
University of Michigan

Ralph L. McNutt, Jr.
Johns Hopkins University

Neil Murphy
Jet Propulsion Laboratory

James Russell III
Hampton University

Roger Wilford Smith
University of Alaska - Fairbanks

William Kent Tobiska
Space Environment Technologies

Appendix C
Presentations

1. *Heliophysics Division Overview*, Steven Clarke
2. *Flight Program Status*, Peg Luce
3. *FY15 Heliophysics Science Performance Assessment (GPRAMA)*, Jeffrey Newmark
4. *Survey of ROSES Panel Process*, Mona Kessel
5. Issues from the NAC Science Committee Meeting, Neil Murphy
6. *NAC Recommendation: Technology Infusion*, Elsayed Talaat
7. *G/MOWG Findings*, Doug Rowland

Appendix D
Agenda

Heliophysics Subcommittee Meeting
September 29-30, 2015

Tuesday September 29; 6H41

9:00	Welcome, Overview of Agenda	J. Dahlburg, HPS Chair
9:15	Heliophysics Division Overview	S. Clarke, NASA HQ
9:45	Flight Program Status	P. Luce, NASA HQ

10:15 BREAK

10:30	Heliophysics Science Performance Assessment Input for the FY2015 NASA PAR – Overview	J. Newmark, NASA HQ
11:00	Heliophysics Science Performance Assessment, input for the FY2015 NASA PAR – Review and Assignments	Subcommittee

12:30 LUNCH: Science Presentation: Space Weather Products at CCMC, Masha Kuznetsova, Marlo Maddux, Leila Mays

1:30	Subcommittee work session(s)	Subcommittee

3:15 BREAK

3:30	ROSES exit survey for proposers and panelists	R. Kessel, NASA HQ
4:00	Cost-to-benefit ratio in flight project reviews, NAC-SC view	N. Murphy, JPL
4:30	PAF, NAC-SC discussion and next steps	J. Dahlburg, NRL; V. Angelopoulos, UCLA
5:00	ADJOURN	

Wednesday September 30: 6H41

9:00	TRL Discussion	E. Talaat, NASA HQ
9:30	G/MOWG report	D. Rowland, NASA GSFC
10:00	Big Data Task Force	E. Smith, NASA HQ

10:30 Break

10:45	Heliophysics Science Performance Assessment, input for the FY2015 NASA PAR -Working	Subcommittee

12:15 LUNCH

1:15	Heliophysics Science Performance Assessment, input for the FY2015 NASA PAR -Working	Subcommittee

3:15 Break

3:30	Heliophysics Science Performance Assessment, input for the FY2015 NASA PAR – Final Work and Voting	Subcommittee
4:15	Discussion, including future meeting dates, potential agenda topics, action items	Subcommittee
4:30	Debrief with Heliophysics Division Director	S. Clarke, NASA HQ
5:00	ADJOURN	